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Concurrent Outbreaks of *Shigella sonnei* and Enterotoxigenic *Escherichia coli* Infections Associated with Parsley: Implications for Surveillance and Control of Foodborne Illness†

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ABSTRACT

In recent years, the globalization of the food supply and the development of extensive food distribution networks have increased the risk of foodborne disease outbreaks involving multiple states or countries. In particular, outbreaks associated with fresh produce have emerged as an important public health concern. During July and August 1998, eight restaurant-associated outbreaks of shigellosis caused by a common strain of *Shigella sonnei* occurred in the United States and Canada. The outbreak strain was characterized by unique pulsed-field gel electrophoresis patterns. Epidemiologic investigation determined that the illness was associated with the ingestion of parsley at four restaurants; at the other four restaurants, the majority of the people who contracted the illness ate parsley. Isolates from patrons in two unrelated restaurant-associated enterotoxigenic *Escherichia coli* (ETEC) outbreaks in Minnesota shared a common serotype and pulsed-field gel electrophoresis (PFGE) pattern. Parsley was the implicated or suspected source of both ETEC outbreaks. In each of the outbreak-associated restaurants, parsley was chopped, held at room temperature, and used as an ingredient or garnish for multiple dishes. Infected food workers at several restaurants may also have contributed to the propagation of the outbreak. The sources of parsley served in outbreak-associated restaurants were traced, and a 1,600-acre farm in Baja California, Mexico, was identified as a likely source of the parsley implicated in six of the seven *Shigella* outbreaks and as a possible source of the parsley implicated in the two ETEC outbreaks. Global food supplies and large distribution networks demand strengthened laboratory and epidemiologic capacity to enable state and local public health agencies to conduct foodborne disease surveillance and to promote effective responses to multistate outbreaks.

In recent years, the occurrence of widely distributed outbreaks associated with contaminated produce items has been recognized as an emerging foodborne disease problem in the United States *(16).* Produce items including raspberries, strawberries, cantaloupe, lettuce, alfalfa sprouts, and tomatoes have been implicated as vehicles in multistate outbreaks of cyclosporiasis, *Escherichia coli* O157:H7 infections, salmonellosis, shigellosis, and hepatitis A *(16).* The widespread geographic distribution and sporadic, low-level contamination of these minimally processed ready-to-eat foods results in outbreaks that are difficult to detect. Most outbreak-associated cases appear as sporadic infections, and only a few might be detected in any given jurisdiction. Furthermore, the increasing importation of fresh produce items from developing countries has increased the potential for foodborne outbreaks of shigellosis and "traveler's diarrhea" caused by enterotoxigenic *E. coli* (ETEC) that are endemic in many of these countries. ETEC outbreaks cannot be detected through laboratory-based surveillance because clinical laboratories do not routinely test for ETEC in the United States. Thus, improved surveillance for clusters of illnesses associated with events or establishments is needed to detect ETEC outbreaks and to identify foodborne-illness causes that are currently unknown or unrecognized *(11).*

In August 1998, six foodborne disease outbreaks were independently reported to the Minnesota Department of Health (MDH) through a statewide foodborne illness complaint system. Preliminary investigations suggested that two *Shigella sonnei* outbreaks might have been part of a larger common-source outbreak and that two of the outbreaks had clinical and epidemiologic characteristics suggesting ETEC as a likely cause. The objectives of this study were to determine whether these outbreaks may have been linked to other, similar outbreaks occurring elsewhere and to identify the sources of the outbreaks. To accomplish these objectives, the MDH began an inquiry into other *Shigella* and ETEC outbreaks in the United States and Canada. With assistance from the Centers for Disease Control and Prevention (CDC) and other coinvestigators, the MDH found that eight *S sonnei* outbreaks in four states and two Canadian provinces were linked to fresh parsley from a common producer *(4).* In ad-

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dition, parsley that might also have come from the same producer was implicated as a vehicle in two concurrent ETEC outbreaks in Minnesota. This report discusses the implications of these investigations for foodborne disease surveillance and outbreak investigations in the United States.

MATERIALS AND METHODS

Foodborne surveillance and outbreak investigations in Minnesota. The MDH was notified of suspected outbreaks through a statewide citizen complaint hotline. Physicians and clinical laboratories also reported several cases of *S. sonnei* infections to MDH, as required by Minnesota's Communicable Disease Reporting Rules. Complainants and people with confirmed *S. sonnei* infections were interviewed by a team of public health students ("Team Diarrhea") to obtain exposure histories for the 7 days prior to illness. Isolates from cases of foodborne illness reported by hospital laboratories were submitted to the MDH as required by reporting rules. Stool samples were obtained from patients reporting illness to the citizen complaint hotline. Stool samples were tested for bacterial, viral, and parasitic enteric pathogens. All isolates of *S. sonnei* and ETEC were routinely subtyped by PFGE. Subtyping results were tabulated daily and shared with epidemiologists to facilitate outbreak detection.

Outbreak notification and detection in other states and Canada. To make possible the detection of *S. sonnei* isolates from additional outbreaks with the same PFGE patterns in the United States and Canada, outbreak-associated patterns for *S. sonnei* isolates were reported to PulseNet, the national molecular subtyping network for foodborne pathogens *(15).* In addition, epidemiologists at the MDH and the CDC made follow-up telephone inquiries to state and local public health officials in the United States and to Health Canada. During the same period, the CDC reviewed national surveillance data for *S. sonnei* reported through the Public Health Laboratory Information System and made additional inquiries by phone and e-mail to 10 states that had reported an increase in *Shigella* cases compared with levels for previous years. State and territorial epidemiologists were notified of the outbreaks by fax and e-mail. Inquires about *Shigella* outbreaks in Canada were made by phone. The CDC also advised all state and territorial epidemiologists of the ETEC outbreaks in Minnesota by a letter that was faxed and mailed.

Epidemiologic method and statistical analyses. To identify the causes of the outbreaks, case-control studies were performed. In the Minnesota restaurant outbreaks caused by *Shigella,* cases were defined as patrons with culture-confirmed *S. sonnei* infections or those who experienced at least 1 day of diarrhea with fever or chills following a meal. In the Minnesota restaurant outbreaks caused by ETEC, cases were defined as patrons with confirmed ETEC infections or those who experienced at least 3 days of diarrhea following a meal. Controls for both *Shigella* and ETEC outbreaks were well meal companions or other restaurant patrons who did not become ill. Standard measures of association between illness and exposure variables were calculated for each restaurant-based case-control study. These measures included odds ratios, 95% confidence intervals (CIs), and P values. Univariate analyses were conducted with the use of EpiInfo, Version 6 (CDC, Atlanta, Ga.). Variables that were significantly associated with illness ($P < 0.05$) by univariate analyses were included in multivariate analyses. Multivariate analyses were conducted with the use of SPSS for MS Windows, Release 6.1. In other states and in Canada, a variety of epidemiologic methods, including case-control studies, case series, and descriptive analyses, were used to investigate the outbreaks.

Traceback and farm investigations. Traceback investigations at the state and provincial levels were carried out with assistance from sanitarians; state, local, and provincial public health offices; and the Minneapolis District Office of the U.S. Food and Drug Administration (FDA). As the investigation expanded, the CDC, the FDA and the Canadian Food Inspection Agency assisted with traceback investigations. A farm investigation consisted of examination of the layout of the fields, determination of the source and distribution of irrigation water, inspection of the sanitary facilities provided for field workers, and determination of the source and treatment of water used in hydrocooling operations at the packing shed *(4).*

Isolate characterization. Isolation, speciation, and serotyping of *S. sonnei* were carried out at state health departments with the use of standard methods *(2).* Sensitivity to antimicrobial agents was determined by clinical laboratories and, when available, by the public health reference laboratory to which the isolate was sent for confirmation. Outbreak-associated isolates were forwarded to the CDC and the MDH for PFGE subtyping with the restriction endonuclease *Xba*1 *(3).*

Emulsified growth and individual colonies from stool cultures were tested for heat-stable (ST) and/or heat-labile toxins (LT) (the two toxins that characterize ETEC infection). Positive polymerase chain reaction (PCR) tests were confirmed by sequencing *(9, 12).* PCR-positive colonies were further analyzed with PFGE subtyping and serotyping. PFGE was performed for ETEC isolates by the same methods and criteria for interpretation described for *S. sonnei.* ETEC isolates were forwarded to the CDC for serotyping.

RESULTS

***S. sonnei* outbreaks.** During July and August 1998, we identified eight restaurant-associated outbreaks of *S. sonnei* caused by similar outbreak strains. Six of these outbreaks occurred in the United States (two each in Minnesota and California and one each in Massachusetts and Florida), and two occurred in Canada (Ontario and Alberta) (Table 1). Restaurant exposures occurred from 24 July through 17 August 1998. The Minnesota outbreaks were initially recognized through multiple reports to the statewide foodborne illness complaint system. Outbreaks in other states and in Canada were also reported and investigated by state or local health officials during or shortly after their occurrence. After the PulseNet inquiry, two outbreaks that had been investigated by local public health officials in Los Angeles County, Calif., were reexamined by local public health officials and linked to the Minnesota outbreaks on the basis of PFGE subtyping results for outbreak-associated isolates. The four other outbreaks were linked after telephone and e-mail inquiries.

In Minnesota, two independent complaints to the MDH on 10 August and a third on 11 August identified groups with diarrhea and at least one confirmed *S. sonnei* infection associated with one restaurant (outbreak 7). Similarly, on 17 August, three independent complaints identified an outbreak of shigellosis associated with a second restaurant (outbreak 1). The two restaurants in Minnesota were located in different counties in the Minneapolis–St. Paul metropolitan area, used different water supplies, and had no common employees (Table 1). In these initial studies, parsley was not identified as a potential vehicle.

TABLE 1. *Restaurant-associated outbreaks of* Shigella sonnei *and enterotoxigenic* Escherichia coli *(ETEC) infections, July and August 1998*

Outbreak	Dates of exposure	Dates of onset	Date outbreak detected	No. of ill people (no. confirmed)	Epidemiologic study results[a]
S. sonnei					
1. Minnesota	24 July–17 August	26 July–15 August	17 August	218 (48)	Parsley implicated (OR, 4.3; 95% CI, 2.4–8.0)[b]
2. California	30 July	31 July–3 August	19 August	9 (6)	Parsley suspected[c]
3. Massachusetts	30 July	1–2 August	11 August	6 (3)	Parsley implicated (RR, 10.0; 95% CI, 1.4–70)[b]
4. California	31 July	1–2 August	5 August	9 (4)	Parsley implicated (OR, 32.0; 95% CI, 1.8–1,381)[b]
5. Ontario, Canada	31 July–3 August	2–27 August[d]	10 August	35 (35)	Parsley suspected, 20/20 ate parsley[e]
6. Alberta, Canada	2–8 August	4–8 August	17 August	4 (4)	Parsley suspected, 4/4 ate parsley[e]
7. Minnesota	5–11 August	9–11 August	10 August	168 (62)	Parsley suspected, 56/61 ate parsley[c]
8. Florida	7–13 August	7–16 August	13 August	37 (1)	Parsley suspected, 37/37 ate parsley[c]
Total	24 July–17 August	26 July–27 August		486 (163)	
ETEC					
9. Minnesota	7–13 August	8–17 August	12 August	42 (4)	Parsley–red pepper mix implicated (OR, 8.2; 95% CI, 1.9–34.8)
10. Minnesota	5–17 August	6–19 August	7 August	35 (8)	Parsley suspected, 35/35 ate parsley[c]
Total	5–17 August	6–19 August		77 (12)	

[a] OR, odds ratio; 95% CI, 95% confidence interval; RR, relative risk.

[b] Parsley was implicated after epidemiologic data were reevaluated with respect to ingredients rather than menu items.

[c] Epidemiologic studies failed to implicate parsley because of similar high rates of consumption among case and control subjects.

[d] Includes five people with secondary transmission; onset dates range from 14 to 27 August.

[e] No epidemiologic studies; all case subjects were exposed to parsley.

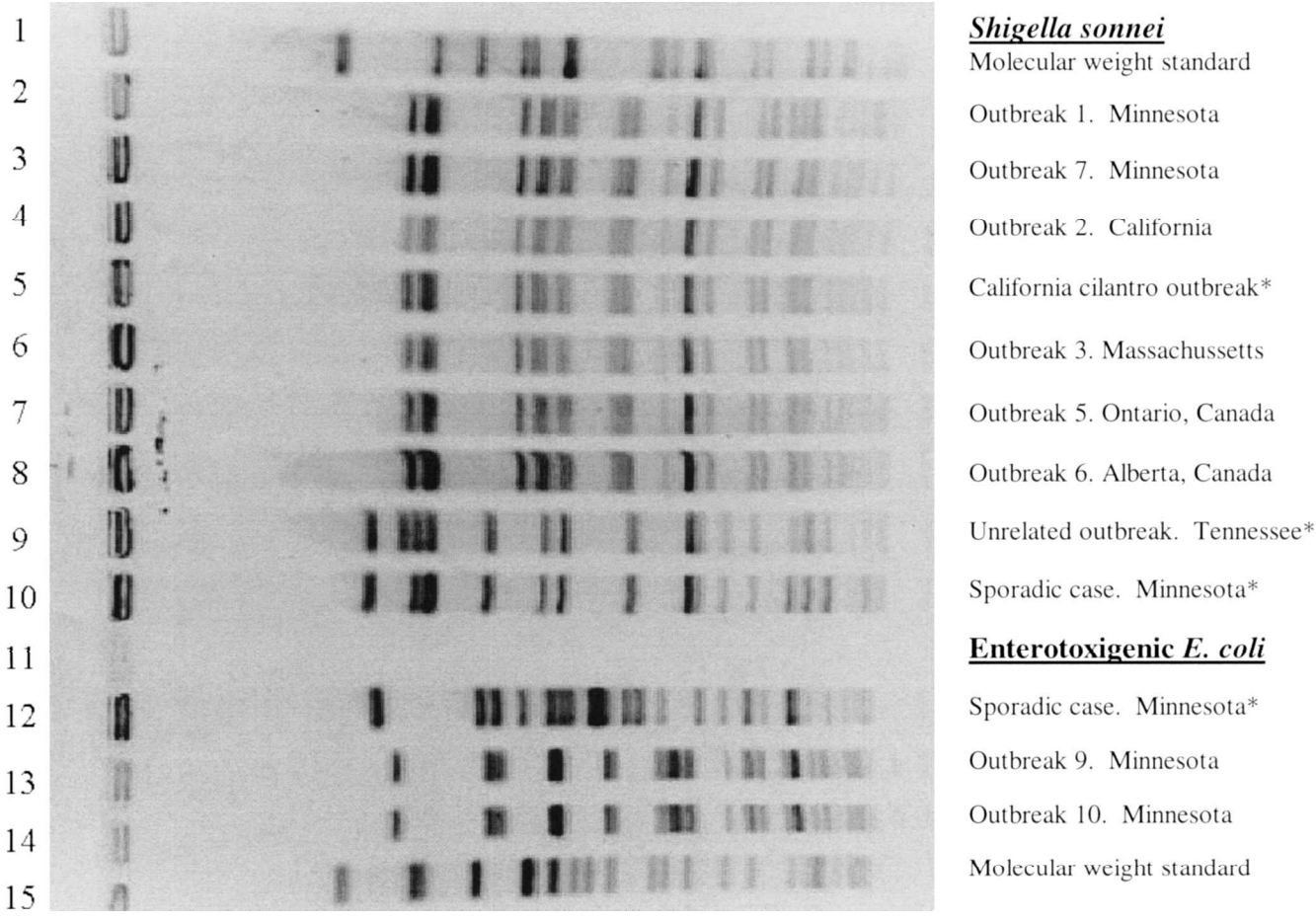

FIGURE 1. *PFGE subtype patterns for* S. sonnei *and ETEC. Lanes 1 and 15, molecular weight standards; lanes 2 through 10,* S. sonnei *PFGE subtype patterns; lanes 2 and 3, the predominant subtype patterns identified in the two Minnesota outbreaks (outbreaks 1 and 7); lane 4, the predominant subtype patterns from one of two outbreaks in California (outbreak 2); lane 5, the predominant subtype pattern from the California cilantro outbreak, which was traced to the same farm as the implicated parsley; lane 6, the predominant subtype pattern from the Massachusetts outbreak (outbreak 3); lanes 7 and 8, the two predominant subtype patterns from the two Canadian outbreaks (Ontario [outbreak 5] and Alberta [outbreak 6], respectively). All of these subtype patterns are clonally related. Lane 10, the most common* S. sonnei *pattern in sporadic cases in Minnesota; lane 9, the predominant subtype pattern identified in an unrelated* S. sonnei *outbreak in Tennessee that also occurred in August 1998; lanes 13 and 14, the indistinguishable LT- and ST-producing O6:H16 ETEC subtype patterns from the two Minnesota ETEC outbreaks (outbreaks 9 and 10); lane 12, an ETEC organism isolated from a Minnesota resident with a sporadic case of travelers' diarrhea. * Isolates not obtained from parsley-related outbreaks described in this report. Cilantro implicated in the California cilantro outbreak was traced to the same farm as the parsley.*

PFGE subtype patterns of outbreak-associated *S. sonnei* isolates were compared with each other and with the library of *S. sonnei* PFGE patterns that had previously been identified in Minnesota since 1995. None of the outbreak-associated subtype patterns had previously been seen at the MDH, which had identified approximately 150 distinct *Shigella* PFGE subtype patterns since 1995. Two closely related PFGE patterns accounted for 90 (77%) of 117 isolates from the two restaurant outbreaks in Minnesota (Fig. 1). All isolates except one had PFGE patterns that differed by no more than three bands, suggesting that these isolates were clonally related on the basis of PFGE *(17).*

After outbreaks 1 and 7 had been linked to *S. sonnei* with the same, or clonally related, PFGE patterns, potential common sources of contamination were sought. In particular, menu items were grouped by ingredient, and the case-control studies were reanalyzed. On reanalysis, uncooked parsley chopped at the restaurant was identified as the likely vehicle in each outbreak. In outbreak 1, multivariate analysis implicated ice (adjusted odds ratio [AOR], 6.9; 95% CI, 2.0 to 23.4) and chopped parsley (AOR, 4.3; 95% CI, 2.3 to 8.4) as sources of illness (Table 1). Five (11%) of 44 restaurant employees had confirmed *S. sonnei* infections (two asymptomatic); three others experienced diarrheal illnesses with fever. No employees reported the onset of symptoms before the occurrence of illness among patrons.

In Outbreak 7, water (AOR, 14.7; 95% CI, 4.2 to 47.9) and lettuce (AOR, 7.5; 95% CI 1.9 to 29.5) were determined to be associated with illness by initial multivariate analysis. Parsley was not significantly associated with illness; however, 56 (92%) of 61 case subjects had eaten a dish containing chopped uncooked parsley. In comparison, 53 (87%) case subjects had drunk water and 51 (84%) had eaten lettuce. Of 32 control subjects, 28 had eaten parsley, 12 had drunk water, and 19 had eaten lettuce. Seven (17%) of 42 restaurant employees had confirmed *S. sonnei* infec-

tions (two asymptomatic), and one other employee experienced diarrheal illnesses with fever. No employees reported the onset of symptoms before the occurrence of illness among patrons.

As was the case for the Minnesota outbreaks, parsley had not been implicated during the initial investigations of the outbreaks in Los Angeles County (outbreaks 2 and 4) and Massachusetts (outbreak 3; Table 1). However, when data were reanalyzed on the basis of ingredients rather than menu items, the consumption of chopped parsley was found to be significantly associated with illness. In two other outbreaks, chopped parsley was not significantly associated with illness; nearly all case subjects and healthy control subjects had eaten chopped parsley. No epidemiologic study was conducted for two outbreaks; however, all identified case subjects had eaten chopped parsley.

PFGE patterns matching the outbreak-associated strains from Minnesota (outbreaks 1 and 7) were identified in two outbreaks in Los Angeles County (outbreaks 2 and 4) and in outbreaks in Massachusetts (outbreak 3), Ontario (outbreak 5), and Alberta (outbreak 6; Fig. 1). A single *S. sonnei* isolate from a Utah resident matched the outbreak pattern, but a subsequent investigation revealed that the patient had traveled to Minnesota and had eaten at one of the affected restaurants. An isolate from an outbreak of *S. sonnei* infections in Florida (outbreak 8), which was unavailable for subtyping, had an antimicrobial susceptibility profile identical to that of the outbreak strain.

Enterotoxigenic *E. coli* outbreaks. From 11 to 14 August, two apparent outbreaks of diarrheal illness with clinical features of ETEC (short incubation with prolonged diarrhea) were reported to the MDH foodborne illness complaint system. ETEC was confirmed as the cause of these outbreaks (outbreaks 9 and 10). These outbreaks occurred in restaurants located in different parts of the state. The restaurant associated with outbreak 9 was located in northern Minnesota. Exposures occurred from 7 to 13 August. Forty-two cases were identified among patrons; the median duration of diarrhea was 8 days. Multivariate analysis implicated a parsley–red pepper mix (AOR, 8.2; 95% CI, 1.9 to 34.8) as the source of illness. Thirty-eight (90%) of 42 case subjects and 8 (35%) of 23 control subjects had eaten the parsley–red pepper mix.

The restaurant associated with outbreak 10 was located in the Twin Cities metropolitan area. Exposures occurred from 5 to 17 August. Thirty-five cases were identified among restaurant patrons; the median duration of diarrhea was 9 days. In a multivariate analysis, a gyros platter (AOR, 5.8; 95% CI, 1.0 to 28.4) was significantly associated with illness, although only 11 (31%) of 35 case subjects had eaten this particular dish. No individual food item on the gyros platter was independently associated with illness. All case and control subjects had been exposed to freshly chopped parsley in various amounts. Chopped parsley was the only ingredient that was common to implicated food items in the two restaurants (Table 1).

Stool specimens from 26 ill patrons from outbreaks 9 and 10 were submitted to the MDH for bacterial culturing. Of these 26 stool samples, 12 were found to have ST and/or LT gene sequences. Six of 12 case subjects were confirmed by PCR on emulsified growth and DNA sequencing; therefore, no isolates were available for serotyping in these six cases. However, *E. coli* isolates were available for serotyping at the CDC for three cases from each outbreak. Isolates for two of three cases from each outbreak had O6:H16 ETEC serotypes, and isolates for one case from each outbreak shared an indistinguishable O6:H16 PFGE subtype pattern. Although O6:H16 is the most common ETEC serotype identified at the CDC, this particular O6:H16 PFGE subtype had not previously been encountered. No *Shigella* was isolated from any stool specimens collected from case subjects in the ETEC outbreaks, and no ETEC was isolated from any stool specimens collected from case subjects in the *Shigella* outbreaks.

Parsley traceback. Invoices faxed from restaurants and produce distributors in Minnesota identified shippers in California as sources for the parsley served at the restaurants during the outbreak period. However, preliminary traceback investigation of these parsley sources identified a likely common source in Mexico. A 1,600-acre farm (farm A) in Baja California, Mexico, was implicated as the likely source of the outbreak. This farm was identified as a possible source of the parsley involved in six of the seven *Shigella* outbreaks (outbreaks 1 through 7). Four farms in California were identified as possible sources of the parsley involved in two to four of these seven outbreaks *(4).* Farm A, along with two other farms in southern California, were identified as possible sources of the parsley involved in the two restaurant-based ETEC outbreaks in Minnesota (outbreaks 9 and 10). Production and distribution dates indicate that the contamination of parsley with the outbreak-associated strain of *S. sonnei* must have occurred on at least 4 days from 9 to 27 July. Contamination of parsley by ETEC would have occurred during this same period. However, it is not possible to determine whether *Shigella*-contaminated parsley and ETEC-contaminated parsley were harvested on the same days or on different days.

Farm investigation. Epidemiologists, engineers, and environmental health specialists from the FDA and the CDC conducted initial field investigations of farm A in October and in February 1999. Investigators found that municipal water, which was used in hydrocoolers in the packing area of the farm, was inadequately chlorinated and vulnerable to contamination. Although the water in the hydrocoolers was changed daily, it was recirculated throughout the day; thus, numerous boxes of parsley could have been exposed to nearly identical contaminants on a given day. In addition, unchlorinated water might have been used to make ice for packing the parsley. Farms in California were not similarly investigated, because no individual farm was identified as a likely source of exposure.

DISCUSSION

The identification of parsley grown in Mexico and shipped across the United States and Canada as the vehicle in these outbreaks highlights the challenge of maintaining

a safe food supply in a modern, global economy. The detection of these outbreaks highlights both the potential and the limitations of national initiatives such as PulseNet as a means to improve foodborne disease surveillance and also suggests a model for how to build better outbreak investigations in the future.

Patrons and public health investigators initially overlooked parsley because it is used as a garnish accompanying or covering many different food items. The initial epidemiologic evidence in most of the individual outbreaks was inconclusive and suggested a local source of contamination, such as an infected food worker. Thus, a combination of traditional epidemiologic methods and molecular techniques was required to tie these outbreaks to a common source. Routine PFGE subtyping of *Shigella* at the MDH provided a frame of reference for use in understanding the significance of the simultaneous appearance of unique shared subtype patterns, which strongly suggested a common source for the two initial outbreaks. For the ETEC outbreaks, the temporal clustering of two unusual outbreaks in different locations, coupled with the unique, indistinguishable ETEC PFGE subtype patterns, strengthened the epidemiologic evidence.

These outbreaks illustrate the changing nature of our food supply and changes in the identities and distributions of foodborne pathogens *(7).* Although *Shigella* and ETEC are important enteric pathogens in many countries, they are not traditionally considered major foodborne pathogens in the United States, where they account for only approximately 1% of known foodborne illness *(11).* The presence of large distribution networks for fresh produce and other foods means that increasing numbers of foodborne outbreaks will be regional, national, or international in scope. For example, raspberries, strawberries, cantaloupe, lettuce, alfalfa sprouts, and tomatoes have been implicated as vehicles in multistate outbreaks of cyclosporiasis, *E. coli* O157:H7 infections, salmonellosis, and hepatitis A *(16).* Recent examples of outbreaks associated with other large-scale food distribution networks include an outbreak of *Salmonella enterica* subtype Enteritidis associated with contaminated ice cream and an outbreak of *Listeria monocytogenes* associated with contaminated processed meat *(6, 8).*

The occurrence of large, geographically dispersed outbreaks of illness associated with contaminated food products requires rapid outbreak detection and investigation to prevent some outbreak-associated cases and to prevent future outbreaks from the same source. One month after the series of outbreaks described in this report occurred, another *S. sonnei* outbreak (with the same PFGE subtype), sickening more than 300 people, occurred in California *(18).* Although contaminated cilantro—not parsley—was implicated as the vehicle in that outbreak, the cilantro was traced back to the same Mexican farm that grew the parsley responsible for the *S. sonnei* outbreaks documented in this report. If the original outbreaks had been detected and investigated sooner, this later outbreak could possibly have been prevented. Thus, finding the outbreak source is still important, even when perishable food items with short shelf lives are involved.

In addition to identifying sources of contaminated food, outbreak investigations can identify risky food-handling practices. In the outbreaks studied here, the holding of large quantities of parsley at room temperature likely increased the risk of sporadic low-level contamination. Laboratory studies show that *S. sonnei* grows rapidly on chopped parsley held at room temperature and suggest that the risk of an outbreak can be reduced by chopping parsley in smaller batches, keeping it refrigerated, and storing it for shorter periods *(19).*

Several methods of foodborne disease surveillance can be improved to minimize delays in the detection and investigation of outbreaks and to build better outbreak investigations in the future. First, statewide foodborne disease complaint systems that are accessible to the public will facilitate quicker detection of outbreaks. In addition, the ability to rapidly interview large numbers of people is critical to reducing the time it takes to characterize outbreaks. The MDH has addressed these needs by establishing a statewide citizen complaint hotline and by assembling a group of graduate public health students to conduct telephone interviews to support outbreak investigations. Techniques to conduct mass surveys of exposed groups by e-mail questionnaires have also been explored by the CDC *(5).* Quickly implicating a food item in an outbreak requires specific source information about potentially contaminated food items that can be used in an epidemiologic analysis. Therefore, product traceback investigations should be initiated when epidemiologic evidence suggests a likely source for an outbreak; traceback investigations should not be delayed until a food item has been definitively implicated or until a pathogen has been recovered from the implicated food item. Furthermore, better record keeping in the produce distribution industry is also critical to conducting rapid and accurate traceback investigations.

Subtype-specific laboratory surveillance is also a critical element of foodborne-disease control. To address this issue, new initiatives are under way to improve cooperation and understanding between state and local public health agencies, the CDC, the FDA, and the U.S. Department of Agriculture. PulseNet was developed by the CDC to standardize PFGE subtyping methods and to maintain a national database of DNA "fingerprint" patterns for each of the major bacterial foodborne pathogens *(15).* Canada has adopted a compatible system and the European Union plans to do so; such systems will create opportunities to detect multicontinent outbreaks.

PulseNet represents an important advance in our ability to investigate foodborne illness because it has the potential to increase the sensitivity of outbreak detection and to increase the specificity of case definitions used in outbreak investigations. The mandatory submission of isolates of foodborne pathogens to public health laboratories would facilitate subtype-specific surveillance of foodborne illness and would ensure the availability of outbreak-associated isolates for the PulseNet system. In the Florida *Shigella* outbreak, for example, clinical laboratories that followed

established protocols had already discarded outbreak-associated *Shigella* isolates by the time these laboratories were contacted by public health officials. Currently, the public health reporting laws in most states do not mandate isolate submission. Although 48 (96%) of 50 states have disease-reporting laws that mandate the reporting of *Salmonella, Shigella,* and *E. coli* O157:H7 infections, only 19 (38%) states mandate the submission of isolates from infections caused by any of these three pathogens (Roush *(14)* and unpublished data from the MDH).

In addition to PFGE subtyping, PulseNet provides a potentially rapid communication tool for use during outbreaks, and its use in this investigation led to the identification of the *Shigella* outbreaks in Los Angeles. However, although most state health departments now participate in the PulseNet system, not all initiate PulseNet inquiries on the basis of outbreaks within their own states. From October 1999 to September 2000, only 25 of 45 (56%) states in the PulseNet system initiated inquiries. Ten states accounted for 52 (68%) of 77 initial PulseNet inquiries made during this period (MDH, unpublished data). The uneven use of the PulseNet system by participating sites at this stage of its development partly reflects disparities between state health departments, some of which lack the resources to routinely investigate foodborne illness *(1, 13).*

To ensure a timely and effective response to multistate and international outbreaks of foodborne disease, state and local public health agencies in the United States and Canada need adequate resources to monitor, investigate, and prevent foodborne illness, including dedicated teams of interviewers to rapidly interview large numbers of people. In the wake of the recent terrorist attacks on the United States and the threat of an attack on the food supply, the need to quickly respond to foodborne outbreaks has greatly increased *(10).* The speed with which outbreaks are investigated should be limited only by the speed with which we can collect and analyze detailed exposure information from case and control subjects or from groups of exposed persons. An improved system should include an expanded PulseNet system along with routine subtyping of foodborne pathogens by state health departments, statewide foodborne complaint systems, and dedicated teams to rapidly conduct interviews during outbreaks. With adequate state and local public health infrastructures, the benefits of new federal food safety initiatives in the United States can be fully realized.

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